A Comprehensive Analysis of Infrastructure Linkages and Multipliers for Australia

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Dedicated to

My Beautiful Wife,

My Wonderful Children

and

My Dearest Grandson Koa Julian

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CERTIFICATE OF AUTHORSHIP/ ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree, nor has it been submitted as part of the requirements for a degree, except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

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LIST OF ABBREVIATIONS AND ACRONYMS

ABARE	Australian Bureau of Agricultural and Resource
ABIX	Australian Business Intelligence
ABS	Australian Bureau of Statistics
ACCC	Australian Competition and Consumer Commission
ACT	Australian Capital Territory
AEMC	Australian Energy Market Commission
AER	Australian Energy Regulator
ANAO	Australian National Audit Office
ANZSIC	Australian and New Zealand Standard Industrial Classification
APGA	Australian Pipelines and Gas Association
APPEA	Australian Petroleum Production & Exploration Association
ARCADIS	A global design, engineering and management consulting company
ASIOT	Alternative Scenario Input-Output Table
ATIC	Australian Trade and Investment Commission
AU	Australia
AUD	Australian Dollar
AWRC	Australian Water Resource Commission
BC	Base Case
BCA	Business Council of Australia
Bcf	Billion cubic feet
BCSIOT	Base Case Scenario Input-Output Table
BITRE	Bureau of Infrastructure, Transport and Regional Economics
BL	Backward Linkages
BL-CI	Backward Linkages Concentration Indices
BL-H2	Highest Contributor to Backward Linkages
BL-I	Backward Linkages Important Coefficients
BL-LI	Backward Linkages Less Important Coefficients
BL-MIC	Backward Linkages Most Important Coefficients
BL-PF	Backward Linkages Primary Factors
BREE	Bureau of Resource and Energy Economics
C-COV	Comparable Coefficient of Variance
CEDA	Committee for Economic Development Australia
CGE	Computational General Equilibrium
CL	Complementary Linkages
COAG	Council of Australian Governments
Col-MIC	Backward Linkages Most Important Coefficients
COM	Coal-to-Oil
ComLAW	Federal Register of Legislation
COV	Coefficient of Variation
CPI	Consumer Price Index
CPM	Carbon Pricing Mechanism
CSG	Coal Seam Gas

CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Coal Seam Gas
CTL	Coal-to-Liquid
CTRE	Centre for Transportation Research and Education
CW	Chenery-Watanabe
CWA	Climate Works Australia
DEA	Data Envelop Analysis
DEE	Department of Energy and Environment
DFAT	Department of Foreign Affairs and Trade
DGI	Data Gaps Initiative
DIIS	Department of Industry, Innovation and Science
DIRD	Department of Infrastructure and Regional Development
DITR	Department of Industry Tourism and Resources
DNRM	Department of Natural Resources and Mines
DSEWPC	Department of Sustainability, Environment, Water, Population and Communities
ED	Exports-Dominant
EIA	Energy Information Administration
ENA	Energy Network Australia
EPA	Environment Protection Authority
Eq.	Equation
ESAA	Energy Supply Association of Australia
ESOW	Equally-Weighted System of Weights
ESSR	Elasticity of Sectoral Supply Response
EU	European Union
FC	Financial Crisis
FDI	Foreign Direct Investment
FDI	Foreign Direct Investment
FD-VA	Final Demand - Value Added
FL	Forward Linkages
FL-CI	Forward Linkages Concentration Indices
FL-H2	Highest Contributor to Forward Linkages
FL-I	Forward Linkages Important Coefficients
FL-LI	Forward Linkages Less Important Coefficients
FL-MIC	Forward Linkages Most Important Coefficients
FRC	Full Retail Contestability
FTE	Full Time Equivalent
G-20 (G20)	Group of Twenty
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GGAS	Greenhouse Gas Abatement Scheme
GGE	General Government Expenditure
GIIA	Global Infrastructure Investor Association

GSP	Gross State Product
GST	Good and Services Tax
GTAP	Global Trade Association Project
GVA	Gross Value Added
H1	Intra-Industry Trade Linkages
H2 to H6	Highest to Lowest Contributors to Linkage Magnitudes
HD	Harrod-Domar
HEM	Hypothetical Extraction Method
I	Important Coefficients
IA	Infrastructure Australia
IAQ	Industry Association of Queensland
IBRD	International Bank for Reconstruction and Development
IC	Industry Commission
ICA	Institute of Charted Accountant
ICOR	Incremental Capital Output Ratio
IDA	International Development Association
IEA	International Energy Agency
IEEE	Institute of Electrical and Electronics Engineers
IeIOM	Infrastructure-embedded Input-Output Model
IeIOT	Infrastructure0Embedded Input-Output Table
IFC	International Finance Corporation
IFGW	Infrastructure Finance Working Group
IMD	Institute of Management Development
IMF	International Monetary Fund
IMPLAN	IMpact analysis for PLANning
IO	Input-Output
IOFQLAF	Input-Output Four-Quadrant Linkages Analysis Framework
IOI	Infrastructure of Interest
IOT	Input-Output Table
IPA	Infrastructure Partnerships Australia
IPART	Independent Pricing and Regulatory Tribunal
LCA	Life Cycle Assessment
LCD	Least Developed Countries
LI	Less Important Coefficients
LNG	Liquefied Natural Gas
LPG	Liquid Petroleum Gas
LQ	Location Quotient
LSES	Linkage Strength Evaluation Score
MCE	Ministerial Council of Energy
MENA	Middle East and North Africa
MF	Market Forces
MIC	Most Important Coefficients

MRET	Mandatory Renewable Energy Target
MRVIO	Multiregional Variable Input-Output
MRW	Mankiw-Romer-Weil
NCC	National Competition Council
NCP	National Competition Policy
NEG	National Energy Guarantee Scheme
NEM	National Electricity Market
NETS	National Emission Trading Scheme
NI	Not Important Coefficients
NLECC	National Low Emission Clean Coal Council
NSW	New South Wales
NSWDPI	NSW Department of Primary Industry
NSWEPA	NSW Environment Protection Authority
NT	Northern Territory
NT	Net Trade
NTC	National Transport Commission
NWC	National Water Commission
NWI	National Water Initiative
NWIDF	National Water Infrastructure Development Fund
NWRC	NSW Water Resource Commission
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
PC	Productivity Commission
PEIM	Preservation Economic Impact Model
PF	Primary Factors
PF-FD	Final Demand Direct Purchases of Primary Factors
PIM	Perpetual Inventory Method
PNG	Papua New Guinea
PPI	Producer Price Index
PRRT	Petroleum Resource Rent Tax
Pub	Public
PV	Photovoltaic
Pvt	Private
PwC	PiecewaterhouseCoopers
Q1	Quadrant One
Q2	Quadrant Two
Q3	Quadrant Three
Q4	Quadrant Four
QLD	Queensland
R&D	Research and Development
R1	Recession 1, 1975

R2	Recession 2, 1977
R3	Recession 3, 1981-83
R4	Recession 4, 1990-91
RAS	Rows and Sums
REDM	Relative Employment Density Model
REMI	Regional Economic Models, Inc.
RET	Renewable Energy Target
RIMS	Regional Input-Output Modelling System
ROW-MIC	Forward Linkages Most Important Coefficients
RRT	Resource Rent Tax
RS	Renewable-Supreme
RST	Rest of the Sectors
S01	Sector Number One
SA	South Australia
SAM	Social Accounting Matrix
SME	Subject Matter Experts
SPIM	Simplified Perpetual Inventory Method
SSC	System of Sectoral Classification
T&D	Transmission and Distribution
TFP	Total Factor Productivity
TSOW	Traditional System of Weights
UBER	Utah Economic and Business Review
UCG	Underground Coal Gasification
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
US	United States
VIC	Victoria
VIO	Variable Input-Output
WA	Western Australia
WC-COV	Weighted Comparable Coefficient of Variance
WCI	World Coal Institute
WEF	World Economic Forum
WSAA	Water Services Association of Australia
WSOW	Weighted System of Weights
WSUD	Water Sensitive Urban Design
WW-I	World War One
WW-II	World War Two
$b	Dollars in Billions
$m	Dollars in Millions
$t	Dollars in Trillions

LIST OF APPENDICES

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ABSTRACT

In view of the widely-recognised importance of infrastructure in promoting socio-economic prosperity, and prompted by the shallowness of our current understanding of the inter-infrastructure, and infrastructure-economy, linkages and (hence) their policy-usefulness - this research develops a comprehensive analyses of such linkages in the Australian context. For this purpose, this research has developed an integrated framework comprising two complementary models, namely, an empiric-analytic model and an Infrastructure-embedded Input-Output Model (IeIOM). Further, this research has analysed linkages, over the period 1975-2015, for 39 major sectors of the Australian economy, including 19 infrastructure sectors. The consequences of National Energy Guarantee Scheme (a major initiative of the Australian government) on the evolution of linkages, to the year 2050, are also analysed. The analyses suggest that the evolutionary trajectory of infrastructure-economy linkages has indeed been shaped by a complex web of interlocked influences whose internal and external logic resides in the economic, socio-cultural and political domains of the nation. The IeIOM has provided quantitative substantiation for these findings, and has established their policy connects. Some of the key findings of this research are that: 1) key sectors of the economy, i.e., sectors with most extended forward and backward linkages are electricity generation, transmission and distribution; gas supply; iron and steel; non-metallic and mineral products; wood products; and agriculture; 2) major sectors in terms of significant forward linkages include a combination of economic (mineral mining, coal, basic-non-ferrous metals, machinery, transport, and construction) and social (households, education, health, etc.) infrastructure; 3) 22 sectors (most notably, gas supply, electricity generation from natural gas, petroleum products, paper manufacturing, food, electricity transmission and distribution, and coal) exhibit highly inelastic sectoral supply and value added responses, thus presenting high risks for downstream production sectors; 4) highly profitable petroleum producing sector does not significantly contribute to value-added, because of its heavy reliance on imported inputs; 5) trends towards increased exports of natural gas, as compared with its use for domestic purposes, is likely to be detrimental to the economic well-being of the nation; and 6) National Energy Guarantee Scheme is unlikely to extend the reach of linkages, thus limiting its usefulness in the broader economic context. These (and other) insights of this research, through their elucidation of key policy-tradeoffs, and – more importantly – through their questioning of preconceived notions about infrastructure-economy linkages, should constitute useful bases for infrastructure policy development – an issue of utmost contemporary significance – as nations around the world endeavour to devise policies for provisioning infrastructure of the future, in the backdrop of rapidly transforming global technological, economic and social landscapes.

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